

An Ecological Comparison of Upland Deciduous
and Evergreen Forests of Central Texas¹

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A B S T R A C T

Scrub evergreen forests cover most of the cedar breaks region of the Edwards Plateau of Central Texas; however, limited strips of deciduous forests are found on north facing slopes just below the limestone caprock. Dominant species occurring in the deciduous forests in descending order of importance include Quercus texana, Q. glaucoides, Juniperus ashei, Diospyros texana, Prunus serotina, Aesculus pavia, Juglans nigra, and Fraxinus texensis. Nineteen woody species were found in the deciduous forests. Forty eight per cent of the species were exclusive to the deciduous forest community. The deciduous forests had a statistically greater number of species/stand and a higher density. The deciduous species found in the strip forests had combined relative density, dominance and importance values of 59, 93 and 72%, respectively. Dominants in the evergreen forest were J. ashei and D. texana, which had relative density, dominance and importance values totaling 90, 97 and 93%, respectively. Total dominance was the same for both communities; however, J. ashei dominance was 20 times higher in the evergreen forests. Soils of the deciduous forests were significantly deeper and rockier. Also, these soils had higher organic contents and water retention capacities. The potential field capacity (PFC) was 3.47 times higher for the deciduous forest soils resulting in a 2.36 fold increase in the water availability index (WAI). Factors regulating distribution and composition of the deciduous forest communities appear to be insolation and PFC, resulting in part from differences in topographic position.

The Edwards Plateau of Central Texas (Fig. 1) occupies an area of approximately 93,000 km². Yet, the area's biogeography and community ecology are relatively unexamined. A number of general floristic studies have been completed in the Edwards Plateau including early habitat descriptions of Hill and Vaughan (1898), Bray (1904 a, b, 1906) and Tharp (1939), as well as the more recent species lists, descriptions and keys of Gould (1969) and Correll and Johnston (1970). Palmer (1920) noted the distinctive species composition of the plant communities that occur in the upper canyons of this region and speculated on their cause, development and maintenance. From this region, however, only three quantitative phytological studies have been identified. Buechner (1944) investigated the range management of the central Edwards Plateau. Van Auken, Ford and Stein (1979a) compared the plant composition of some upland forests and strip creek bottom riparian communities of the southern Edwards Plateau; and Van Auken, et al. (1980) reported on similarities between upland forest communities occurring on the Edwards and Glen Rose Limestones.

The Edwards Plateau has been treated as a separate physiographic unit, since it possesses a distinct flora including a number of endemics (Blair, 1950; Correll and Johnston, 1970). The western limits of many eastern species lie along the floodplains of the rivers of the Edwards Plateau including bald cypress (Taxodium distichum), sycamore (Platanus occidentalis), pecan (Carya illinoensis) and others (Palmer, 1920; Blair, 1950). South-western species such as J. ashei, D. texana and Q. fusiformis may be found along the dry ridges in the Edwards Plateau but usually not much farther north or east. The upland Plateau flora shows some relationship to the flora of northern Mexico (Correll and Johnston, 1970).

The cedar brakes region of the Edwards Plateau consists of deeply eroded limestones of the Glen Rose and Edwards Formations (Sellards, Adkins and Plummer, 1932). This region occurs along the southern and eastern third of the Plateau. Climatographically, the area is dry, sub-humid to semiarid, and mesothermal (Thornthwaite, 1948). The approximate mean annual temperature for the area is 20 C with about 72 cm/yr rainfall (Arbingast, et al., 1976). Area soils are usually shallow and underlain

by limestone or caliche (Gould, 1969). Whittaker (1975) suggested a thorn-scrub savanna community for a geographical region having climatic characteristics as indicated above, however, this is not the case in the Edwards Plateau. The cedar brakes region is generally dominated by a juniper-live oak-persimmon forest (Van Auken, et al., 1980). However, upland deciduous forest is found in certain habitats within this region.

This paper compares the Edwards Plateau cedar brakes ridge top physiographic unit, which is a juniper-oak-persimmon forest, with a north-east facing deciduous forest community. Spatially, the deciduous forests are closely associated with the juniper-oak-persimmon forest; although^S_A botanically and ecologically they are quite dissimilar. Biotic and abiotic factors were measured and compared in order to obtain a quantitative description of the two communities. These comparisons were used to postulate the major factors allowing deciduous forest development within a predominantly evergreen forest formation.

MATERIALS AND METHODS--The present study was carried out in the cedar brakes region of the Edwards Plateau of Central Texas (Fig. 1). Upon completion of a reconnaissance of the study area, 15 mature, undisturbed stands (grazed but without visible signs of fire or cutting) were selected for study. Nine hillside deciduous forest stands ($4.03 \pm .43 \text{ ha} = \bar{x} \pm \text{SE}$) were selected for study as were 6 hilltop evergreen forest stands ($10.10 \pm 1.04 \text{ ha}$).

The point-centered-quarter method was used to collect quantitative phytosociological data (Cottam and Curtis, 1956). All transects were initiated 50-100 m from a stand edge and followed a predetermined line perpendicular to the drainage. Twenty-five to thirty-five points per

transect were sampled at 10 m intervals. A perpendicular was laid to the chain at each point and within each quarter the plant closest to the point and at least 3.0 cm in stem circumference at ground level was identified and measured. Ground level measurements were used to alleviate problems associated with the shrubby, branching pattern of many species in this area. Plant circumferences (m) point-to-plant distances (m) and plant identifications were determined and recorded. These measurements were used to calculate total density (plants/ha) and individual species density, dominance, and frequency. Importance values were determined by summing the relative density and relative dominance for each species and dividing by two. The above values were calculated for each stand and the mean and standard error were determined for each species in all similar stands (Steel and Torrie, 1960).

Nomenclature and plant identifications are after Correll and Johnston (1970). Density curves and species curves were plotted for each stand; however, these figures are not presented.

Three soil profile pits were dug in each stand. The pits were equally spaced along the transect line. The pits were dug to bedrock and depth measurements made. A soil sample was collected from the surface soil layer at each site. These samples were placed in plastic bags and transported to the laboratory for analysis. Soils were air-dried for 48 hrs., weighed, and the rocks and gravel removed and weighed, then the soil was pulverized and screened through a 2.0 mm mesh standard sieve. The percent rock was determined by dividing the weight of the nonsieved portion of the sample, by the weight of the total sample and multiplying by 100. The pH was determined from a saturated soil paste (Richards, 1954). Particle size distribution for the screened soil was determined using the hydrometer method (Bouyoucos, 1962) on fifty gram sample of air-dried soil. Water retention

capacity (%) was determined according to the methods of Richards (1954).

Organic content was determined colorimetrically after wet digestion with

H₂SO₄ (Jackson, 1958).

Potential field capacity was calculated as follows:

$$PFC = VDFW$$

Where

V= Soil column volume (m³)

D= Soil density (g/m³)

F= % Soil <2.0mm

W= Water retention capacity (%)

Sample distributions were compared and significance levels were evaluated using the Mann-Whitney U-test (Mendenhall, 1975).

RESULTS--Twenty-three species were found in the two forest communities studied (Table 1). Nineteen woody species were found in the deciduous forest with 11 occurring exclusively in this community. Twelve species were found in the evergreen forest with only 4 (17%) limited to this community. Eight species (35%) were common to both forest communities.

J. ashei and D. texana were found in every stand in both the deciduous and the evergreen forests (Table 2). Q. glaucoides and Q. texana occurred in all of the deciduous forest stands. Q. glaucoides was found in only two of the evergreen forest stands. Q. fusiformis, on the other hand, occurred in 83% of the evergreen forest stands studied but only 1 deciduous forest stand. A. pavia, P. serotina, J. nigra, F. texensis and Ungnadia speciosa were found in most of the deciduous forest stands but did not occur in the evergreen forests.

Importance, density, dominance and frequency values for the 11 most important species found in the two communities are included in Table 3. J. ashei and D. texana were the two most important species in the evergreen forest stands with a combined importance value (IV) of 92.8, compared to a combined IV of only 24.7 in the deciduous stands. The two most important species in the deciduous forests, Q. texana and Q. glaucoides had a combined importance of 41.5. Four other deciduous species (P. serotina, A. pavia, J. nigra and F. texensis) had a combined IV of 30.1. These species plus the oaks had a combined IV of 71.6.

Deciduous forest stands had significantly greater ($p < 0.01$) average species richness and average density than the evergreen stands. An average of 10.6 ± 0.5 species was found in each deciduous forest stand while an average of 6.5 ± 0.7 species was found in the evergreen forest stands. The average density (Table 3) in the deciduous stands was 1851 plants/ha compared to 970^{PLANTS}/ha for the evergreen stands. Total dominance, however, was the same in both forest types.

Several patterns emerge when individual species density and dominance values are examined (Table 3, 4). J. ashei had the highest density in both communities (Table 3). D. texana had the second highest density in the evergreen forests and fourth highest density in the deciduous forests even though the densities were numerically equal (Table 3). The combined densities of J. ashei and D. texana in the evergreen stands and deciduous stands were 875 and 759, respectively. On a relative basis these two species accounted for 90.2% and 41.0% of the total density. The 6 dominant deciduous species account for the remaining 59% of the total density in the deciduous

forest stands.

Although total dominance was the same, there were significant differences in the distribution of dominance between the species in the two communities.

Juniperus ashei accounted for 94.5% of the total dominance in the evergreen forest stands but only 4.9% of the total dominance in the deciduous forest

stands ($p < 0.01$ Table 4). The dominant species in the deciduous stands

were Q. texana, Q. glaucoides, P. serotina, J. nigra and F. texensis

(Table 3). They accounted for 89.6% of the total dominance in the deciduous forest stands and less than 1% of the total dominance in the evergreen stands.

J. ashei had the highest frequency value for all species (Table 3)

in both communities (95% evergreen and 58% deciduous forest stands). D. texana (55%) in the evergreen stands, while Q. texana was the second most frequent species (46%) in the deciduous stands.

Other frequently occurring species in the deciduous forests were

D. texana (40%), A. pavia (34%), and Q. glaucoides (31%).

Juglans nigra with an average basal area of 1023 cm²/plant was the largest tree found in either community. It was almost twice as large as P. serotina, the species with the second largest average dominance (Table 5).

Quercus texana, F. texensis, Q. fusiformis, Q. glaucoides and Bumelia lanuginosa were the next largest trees in descending order of average

basal area in the deciduous forests. Although J. ashei was the largest species present in the evergreen forests, it was tenth largest in the deciduous forests. D. texana was the fourth largest species in the evergreen forests

and the twelfth largest in the deciduous forests. Nevertheless, there was no apparent difference in the size of D. texana between the two forest

types. J. ashei was 15 times larger in the evergreen forests while Q.

fusiformis was twice as large in the deciduous forests.

Many physical factors were significantly different between the two communities. The deciduous forest stands had essentially a closed canopy averaging 91.9% cover, while the evergreen forest stands had a relatively open canopy averaging 54.4% cover (Table 6). The average aspect of the deciduous forest stands was $36.8^\circ \pm 9.6^\circ$ or northeast facing. All evergreen forest stands studied were hilltop stands of low slope ($\bar{x} = 4^\circ \pm 1.3^\circ$), however the average slope of the deciduous forest stands was $31.5^\circ \pm 0.8$.

Soils from the two communities were limestone derived Tarrant or Tarrant-Brackett soils (Hensell, Dittmar, and Taylor, 1977). Deciduous forest soils were significantly ^{DEEPER,} rockier, higher in pH but lower in clay content (Table 7). Although the percent organic material was higher in the deciduous forest soils ^{THE VALUE} was not significant. Water retention capacity of the deciduous forest soils averaged 10% higher than the evergreen forest soils (Table 8), although not significantly higher. Deciduous forest soils HAD A PFC OF 4549 g of water/100cm² soil column or 3.47 times more water than the evergreen forest soils (Table 8). Over 1715 Kg more water was available per plant in the deciduous forests or 2.36 times as much water was available per plant as in the evergreen forests (Table 8).

DISCUSSION-- The delineation of plant communities in the field is frequently problematical and highly debated (Brush, Link, and Smith, 1980; La Roi and Hnatiuk, 1980; Whittaker, 1951; Curtis and McIntosh, 1951; Whittaker and Niering, 1975; Peet and Louks, 1977, Adams and Anderson, 1980).

No P
In the present study, the two communities described are very distinct and easily identified in the field based on physiographic as well as botanical

parameters; however, the two communities are part of a postulated complex moisture availability gradient or continuum. This moisture availability gradient affects the extent, density, dominance and species composition within the two described communities, however, these effects within the separate communities, although considerable, are reduced in magnitude when compared to the major differences that appear between the two communities. To address the within-community differences and causes is not within the scope of this paper. Between community differences are probably due to topographic position and soil depth as reflected in potential field capacity. The gradient between pairs of these communities is usually very steep, and the ecotone between them only extends over a short distance, possibly 50m or less. Over that short distance the soil depth changes drastically as does the slope and the plant community itself.

The mesic end of this proposed gradient would consist of the flood-plain forests of the ²m^Aor rivers crossing the Edwards Plateau (Van Aiken, et al., 1979a; Ford and Van Aiken, 1980). The xeric end of the continuum would be either the hilltop evergreen forests described in this paper or the evergreen forests of the south facing slopes of this same region. Intermediate physiographic forest units would probably consist of (from mesic to xeric) intermittent creek fringe forests, upland deciduous forests, canyon floor forests and finally the lower foothill evergreen forest. Preliminary community ordinations have suggested this pattern (Van Aiken, Ford and Dougherty, 1979^b~~x~~).

The distributions of the dominant species found in the Edwards Plateau upland forests are very interesting to say the least. The evergreen forest species have mainly southwestern affinities. J. ashei, D. texana, Q. fusiformis AND S. secundiflora make up 97% of the community IV and are found

not only in central Texas but also in New Mexico and Northern Mexico (Correll and Johnston, 1970). No eastern deciduous forest species were found in these communities.

APPROXIMATELY

The dominant deciduous forest species accounting for $\sim 75\%$ of the IV are either distributed mainly in central Texas such as Q. glaucoides

(IV = 17%) or endemic to the Edwards Plateau such as Q. texana and F. texensis (30%), or eastern species such as P. serotina, J. nigra, and A. pavia (25%) (Correll and Johnston, 1970).

Undoubtedly, the eastern deciduous forest species play an important role in the upland deciduous forest communities. Nevertheless, the role of the endemics and those species with ^{south} western affinities cannot be disregarded.

Apparently the microclimate of these deciduous forest stands is such that it can accommodate some eastern and western species and has allowed the development and maintenance of several endemics. We have some indication that the species composition and ecological makeup of these deciduous forests are changing possibly because of changing climatic conditions (unpublished demographic data).. In the future there may be few or none of the current deciduous species. Instead, these areas may be completely dominated by J. ashei and D. texana.

The increased species richness in these deciduous forests may be due to the greater potential field capacity of the soil (Table 8). Higher species diversity values for woody species at mesic rather than more xeric or hydric sites have been reported by a number of investigators (Whittaker, 1956; 1960; 1965; Monk, 1967; Auclair and Goff, 1971; Whittaker and Niering, 1975; Bell and del Moral, 1977; Adams and Anderson, 1980).

Total dominance values for the two community types were not significantly different, however, significant differences might have been expected based on other reports (Whittaker and Niering, 1975; Adams and Anderson, 1980). Even though total dominance was the same for both communities, dominance of J. ashei was 20 times higher in the evergreen forests. The reverse was essentially true for the deciduous species in the deciduous forests. Water use efficiency versus photosynthetic efficiency could be expected to differ drastically in these species thus altering dominance values (Ting, Johnson, and Szarek, 1972).

Total dominance equality was maintained by J. ashei, the major contributor to the dominance in the evergreen forests, with 3.47 times less water available. However, care must be taken in interpretation because dominance was measured as basal area. If dominance was determined as plant height, canopy cover, canopy volume or total biomass, the dominance trend would probably be altered with the deciduous forests having the highest value. If diameter was measured at breast height as is done in other forests, the deciduous forest would have higher dominance values, possibly by several times, but because of the growth pattern of many species such as J. ashei and D. texana such measurement was not practical and would have resulted in a significant distortion of dominance values.

Total density was significantly higher in the deciduous forests. However, the density of J. ashei and D. texana was the same in both communities. The higher density found in the deciduous forests was due to the presence of the deciduous species not found in the evergreen forests. J. ashei had the same density values in both communities but a lower dominance value in the deciduous forests. Juniperus virginiana has been reported as an old field invader and is well adapted to old field conditions such as

high surface temperature, low water potential and high light intensity (Ormsbee, et. al, 1976). J. ashei probably responds in a similar manner to the same conditions. The light intensity at the base of the deciduous forests would ~~GROWTH AND DEVELOPMENT AND PROBABLY CAUSING THE LOW JUNIPER~~ be quite low thus limiting juniper dominance value.

Crowther and Harper (1965) found that edaphic factors, especially the soil water holding capacity and soil water storage, were probable causative factors in the development of aspen forest strips rather than oak or mountain brush strips in central Utah. Many authors have determined (Parker, 1980; Fonteyn and Mahall, 1978) or at least postulated (Whittaker and Niering, 1965; Adams and Anderson, 1980) the importance of the availability of sufficient water to allow development of specific communities. Community productivity is also related to available water (Lieth, 1973). Indeed, our data indicates the importance of edaphic factors (as well as topographic position) in the development of the upland deciduous forests in the Edwards Plateau.

Aspect and slope differences have been cited by many investigators as being very important factors in determining plant community development (Whittaker, 1975; Smith, 1980). Our data shows that aspect is very important in determining deciduous forest community development in the Edwards Plateau region of central Texas. The northeast aspect is important because of a reduction in incoming solar radiation, resulting in lower evaporation potentials and lower temperatures in the deciduous forest stands.

The deeper soils and greater moisture availability on the steeper hillsides could account for the presence of the eastern deciduous species. However, these factors do not explain why these deciduous species have

apparently out-competed the juniper and persimmon. This competition may relate to faster growth rates for the deciduous species under conditions of sufficient water availability coupled with reduced light intensity in the stands once the canopy closes. The light requirements of J. virginiana have been mentioned previously (Ormsbee, et al., 1976).

The higher potential field capacity of the deeper deciduous forest soils coupled with the reduced solar radiation and lower temperatures on the north facing slopes causing lower moisture demands seems to allow the development of deciduous forests in these areas.

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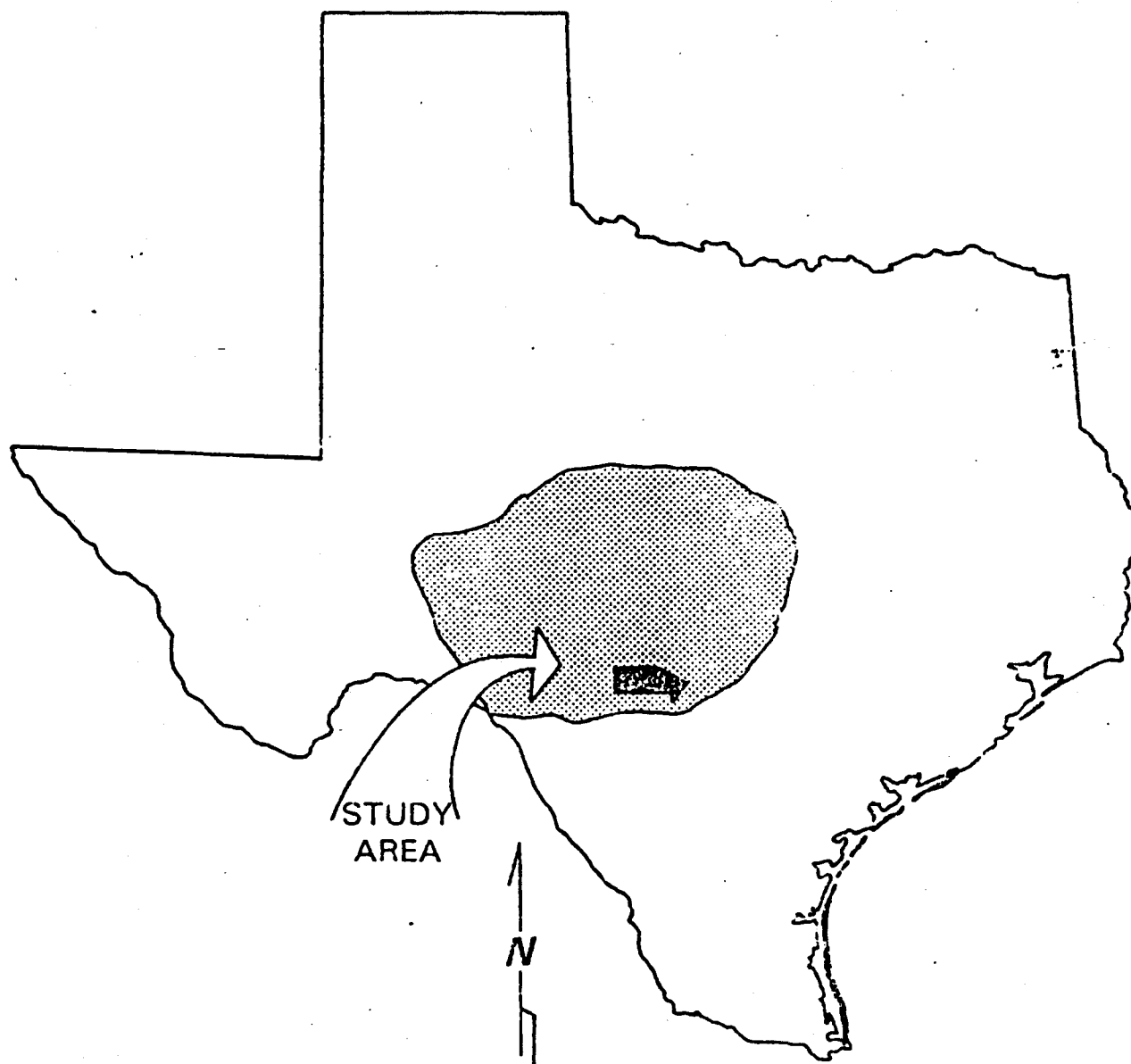
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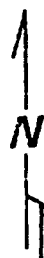
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Figure 1. The State of Texas showing the Edwards Plateau region
(stippled) and the study area in Bandera County (black).



STUDY
AREA



EDWARDS PLATEAU



BANDERA COUNTY

TABLE I

Comparison of species distribution in the deciduous and evergreen forest *STANDS*

SPECIES DISTRIBUTION						
	<u>Deciduous Forest</u>		<u>Evergreen Forest</u>		<u>Both Areas</u>	
	Number	Percent	Number	Percent ^a	Number	Percent
Species Found	19	83	12	52		
Exclusive Species	11 ^a	48	4 ^b	17		
Common Species					8 ^c	35
Total Species					23 ^d	100

$$a + b + c = d$$

^a Percent of total species found in both areas

TABLE 2

Comparison of presence data for the deciduous and evergreen forest stands

Presence data (%)^a

SPECIES	Deciduous Forest ^b	Evergreen Forest ^c
<u>Juniperus ashei</u>	100 ^d	100 ^e
<u>Diospyros texana</u>	100	100
<u>Quercus glaucoides</u>	100	33
<u>Quercus texana</u>	100	— ^f
<u>Aesculus pavia</u>	89	—
<u>Prunus serotina</u>	89	—
<u>Juglans nigra</u>	78	—
<u>Fraxinus texensis</u>	78	—
<u>Ungnadia speciosa</u>	78	—
<u>Quercus fusiformis</u>	11	83

a Percent occurrence in all stands of a particular forest type.

b Other exclusive lower presence deciduous species were Ptelea trifoliata, Parthenocissus quinquefolia, Celtis reticulata, and Vitis Berlandieri. Other species found in both communities were Sophora secundiflora, Berberis trifoliata, Salvia ballotae-flora and Opuntia Lindheimeri.

*c Other exclusive evergreen forest species were Rhus virens, Condalia hookeri, Forestiera reticulata, and Echinocereus sp.

d 9 stands examined

e 6 stands examined

f Not encountered

Table 3. Comparison of the importance, density, dominance and frequency values for ^{THE} deciduous forest communities ^{ies} and evergreen forest communities in the cedar-brakes region of the Edwards Plateau of Texas.

Density ^c			Dominance ^d				Frequency ^e		
duous		Evergreen	Deciduous		Evergreen		Deciduous		Evergreen
<u>+24</u>		---	12.8	<u>+2.0</u>		---	46	<u>+4</u>	---
<u>+77</u>	7	<u>+ 6</u>	8.9	<u>+2.4</u>	.2	<u>+ .1</u>	31	<u>+7</u>	2 <u>+ 2</u>
<u>+93</u>	668	<u>+150</u>	1.9	<u>+ .5</u>	38.6	<u>+5.4</u>	58	<u>+5</u>	95 <u>+ 3</u>
<u>+45</u>	207	<u>+ 39</u>	.8	<u>+ .3</u>	1.0	<u>+ .4</u>	40	<u>+6</u>	55 <u>+11</u>
<u>+19</u>		---	4.8	<u>+1.2</u>		---	17	<u>+4</u>	---
<u>+106</u>		---	.8	<u>+ .4</u>		---	34	<u>+8</u>	---
<u>+ 9</u>		---	4.5	<u>+1.7</u>		---	10	<u>+2</u>	---
<u>+21</u>		---	3.6	<u>+ .9</u>		---	12	<u>+3</u>	---
<u>+13</u>		---	.2	<u>+ .1</u>		---	9	<u>+3</u>	---
<u>+12</u>	10	<u>+ 8</u>		h		h	7	<u>+3</u>	3 <u>+ 3</u>
<u>+ 1</u>	39	<u>+ 19</u>		h	.9	<u>+ .8</u>	i		12 <u>+ 6</u>
	39		.3		.1		6		18
370			38.6		40.8		270		185

st ^a Presented as a percent

^f Mean ± standard error

^g Not encountered

h $< 0.1\text{M}^2/\text{hectare}$

i < 1

TABLE 5

Comparison of the average dominance of the deciduous and evergreen forest stands

Average dominance - basalarea^a

SPECIES ^b	Average dominance - basalarea ^a	
	Deciduous Forest	Evergreen Forest
<u>Juglans nigra</u>	1023	- ^c
<u>Prunus serotina</u>	598	-
<u>Quercus texana</u>	482	-
<u>Fraxinus texensis</u>	480	-
<u>Quercus fusiformis</u>	455	233
<u>Quercus glaucoides</u>	375	251
<u>Bumelia lanuginosa</u>	91	-
<u>Ungradia speciosa</u>	65	-
<u>Salvia ballotaeflora</u>	46	2
<u>Juniperus ashei</u>	38	577
<u>Opuntia Lindheimeri</u>	35	4
<u>Diospyros texana</u>	32	47

^a cm²/plant

^b 11 other species were encountered

^c Not encountered

TABLE 6

Comparison of the percent cover, slope and aspect of the deciduous forest and the evergreen forest stands

	<u>N</u>	<u>% Cover^a</u>	<u>Slope Angle^b</u>	<u>Aspect</u>
Deciduous Forest	7	91.9 $\pm$ 2.0 ^c	31.5 $^{\circ}$ $\pm$ 0.8	36.8 $\pm$ 9.6 ^d
Evergreen Forest	5	54.4 $\pm$ 2.6 ^f	4.0 $^{\circ}$ $\pm$ 1.3 ^f	- e

a $n_D=7, n_E=5$

b $n_D=21, n_E=15$

c $\bar{x} \pm S.E.$

d North = 0

e Hill top

f Significantly different at the 0.01 level (Mann-Whitney U-Test)

Table 7
Comparison of Soil Physical Factors
of the Evergreen and Deciduous Forests

Parameter	Evergreen ^a	Deciduous ^b
Soil Depth ^{de}	21.4±2.8 ^e	103.8±6.7
Soil density weight/volume ^f	0.873±0.062	0.882±0.042
<u>Total Soil Composition</u>		
% Rock ^d	34.4±0.5	52.9±3.5
% Sand	10.2±0.9	8.4±0.7
% Silt	19.9±0.5	18.8±0.9
% Clay ^d	35.5±1.1	19.9±1.4
pH ^d	7.27±0.09	7.50±0.02
% Organic Material	13.7±3.7	19.2±1.3

a $n=3$ EXCEPT SOIL DEPTH $n=15$

b $n=5$ EXCEPT SOIL DEPTH $n=21$

c $\bar{x} \pm SE$

d Significantly different ($p < 0.05$, Mann-Whitney U-Test)

e cm

f g/ml

Table 8
Comparison of Evergreen Forest and Deciduous Forest
Soil Water Relations

Parameter	Evergreen ^a	Deciduous ^b
Water Retention Capacity	93.9±8.5% ^c	103.7±3.8%
Potential Field Capacity ^{df}	1311±351g	4549±322g
Difference		3238g
PFC Ratio (Ev/Dec)		3.47
WAI (Water Available/plant) ^{ef}	1257±202kg	2975±549kg
Difference		1715kg
WAI Ratio (Ev/Dec)		2.36

a n=3

b n=5

c $\bar{x} \pm S.E.$

d Based on a 100 cm² soil column

e $\bar{x}$ area/plant x PFC

f Significantly different ($p < 0.05$, Mann-Whitney U-Test)